Original Article

Clinical and Laboratory Parameters Monitored in Children Extubated from Ambu Bag and Endotracheal Tube

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Objective: To study the clinical and laboratory parameters of children extubated from ambu bag and endotracheal tube after being manually ventilated for at least more than 24 hours.

Methods: Various clinical and laboratory parameters were evaluated initially at the time of intubation and then at the time of extubation. The clinical parameters evaluated included the heart rate & respiratory rate, Glasgow coma scale, spontaneous respiratory effort, respiratory distress and pupillary reaction. The Laboratory parameters evaluated included TLC, CRP, arterial blood pH, HCO3, PO2 & PCO2, CXR, flow rate of oxygen required to maintain oxygen saturation and the dose of cardiac support in the form of dopamine infusion.

Results: Total 24 patients were included in the study, 11(46%) male and 13(54%) female. Age range was from 0 to 36 months with mean of 6.5 months. The mean values of Laboratory parameters at the time of intubation included a pH of 7.13, HCO3 17, O2 sat 64, PCO2 52, and rate of oxygen flow 3.5 liters/min. The mean values of same parameters at the time of successful weaning were, pH 7.36, HCO3 18, O2 sat 94, PCO2 29, and rate of flow of oxygen 3.5 liters/min. Regarding clinical parameters the mean value for GCS at intubation was 5 which later improved to 13 at extubation. Similarly the pupillary reaction at intubation showed constriction of pupils in 6(25%) and mid-dilated with sluggish reaction in remaining 18(75%), while almost 95% cases had reactive pupils at extubation.

Conclusions: Ambu-bagging though crude but is a successful tool for respiratory support in the absence of ventilator. Clinical and lab parameters can predict the outcome in children who are solely intubated and ventilated by ambu bag.

Keywords: Ambu-bagging, Endotracheal tube, Wean-off, Extubation

Introduction

The Ambu bag is an important emergency tool which offers the basic airway management for the ventilation and oxygenation of the patients until the other definitive airway is established.[1] Although ventilators are the recommended tool for mechanical ventilation, but are not necessarily life savers. Short of very few well equipped hospitals in most of the hospitals, being on ventilator is a ritual before inevitable death...a horrible truth. Due to the lack of adequate number of mechanical ventilators in many tertiary care hospitals all around the country, ambo bagging still remains an alternate arrangement in order to ventilate children with respiratory failure. Although majority of the time this bagging is done by untrained patient's attendants but children including newborns are still successfully weaned off from this crude ventilation support. Weaning is a tricky process even in mechanical ventilation by a ventilator. When the acute phase of the disease subsides, noted by a decrease in the mean airway pressure required, weaning begins. The end of weaning can be defined as the time at which the patient's spontaneous breathing alone can provide effective gas exchange.[3] Predicting extubation failure (EF) is one of the most challenging aspects of critical care medicine.[4] For over two decades, physicians have attempted to define the best methods of discontinuing mechanical ventilation in patients recovering from respiratory failure. An early study of weaning noted that the clinical decision to discontinue mechanical ventilation is often arbitrary, based on “judgment and experience”.[5] Difficulty in discontinuation from ventilation is in part attributed to inadequate understanding of the mechanisms responsible for successful outcome and a lack of optimal guidelines to wean off from mechanical ventilation.[6] Generally in case of mechanical ventilation it is desirable to have predictive indexes that can be easily measured and widely applied. A number of indexes, such as vital capacity, maximal inspiratory pressure (PImax), and minute ventilation (VE), have been proposed as accurate predictors of the outcome of weaning.[7]

Many clinicians believe that, for an infant or young child, respiring through a small ETT is akin to breathing through a straw thereby imposing an unacceptable work of breathing. This notion is contrary to both clinical observation and physiology. Data from Keidan and colleagues show the work of breathing through an ETT to be half the effort required for the mask and oro-pharyngeal airway. They also found that breathing spontaneously with a face mask in place required even more work than when there was no oro-pharyngeal airway. A 3 kg infant accepts a 3.0 mm ETT whereas an adult of 60 kg can tolerate a 9.0 mm ID ETT -- a 20 times increase in body size but only a 3 times increase in ETT size. The sub-glottic area of the infant is also 20 times greater in proportion to body size than that of an adult. Nonetheless, the inverse 4^{th} power relationship of airflow resistance to radius dictates that the infant ETT has a much higher "resting" resistance, but it is irrelevant because of the shorter ETT and low flows generated by the infant compared to the adult (*vide infra*). The net effect is that the infant is breathing through a hose rather than a straw when compared to the adult.[3]

Methods

This study was carried out in Department of Pediatrics Jinnah Hospital, Lahore for a period of 07 months from Oct 2012 to April 2013. It was a prospective collection of data. Children including neonates (more than 35 weeks gestation) who were ventilated by ambu bagging and endotracheal tube with oxygen flow due to non-availability/occupancy of ventilators and later successfully weaned off were included in the study. Various clinical and laboratory parameters of children at intubation, and then at extubation were studied. The rationale of study was based on the fact that due to inadequate number of mechanical ventilators for children, all over the country, ambu bagging still remains the tool of ventilation, at times, even for days.

Therefore a study of available clinical data of children who were successfully weaned off will keep the hope alive in such children even without the available facility of mechanical ventilators. 24 successive children who were weaned off were enrolled in the study. The Inclusion criteria was: All neonates(gestational age, 35 weeks and above) and children who were mechanically ventilated using only ambu bag with endotracheal tube for at least 24 hrs, due to non-availability/occupancy of mechanical ventilators and later successfully extubated. The Exclusion criteria included: Neonates < or = 35 wks gestation and children with neuromuscular disease, children partially ventilated mechanically by a ventilator children with fixed dilated pupils and absence dolls eye movement at the time of intubation children with congenital anomalies, neuromuscular diseases and children intubated for less than 24 hours.

Neonates <35 weeks have other contributing factors which make it difficult to wean off from any type of ventilation, therefore were excluded. As an operational definition, extubation as a success was defined as spontaneous maintenance of O_2 Sat without ambu bagging for more than 48 hours after extubation. Similarly a failure was defined as re-intubation within 48 hrs of extubation in the absence of upper airway obstruction.

The list of underlying diseases leading to intubation with percentages was tabulated in order of frequency. The clinical parameters evaluated included the heart rate & respiratory rate standardized to age, conscious status by Glasgow coma scale, spontaneous respiratory effort, respiratory distress in the form of sub-costal, inter-costal recessions and pupillary reaction. The Laboratory parameters evaluated included the TLC, CRP, arterial blood pH, HCO_3, PO_2 & PCO_2, CXR, flow rate of oxygen required to maintain oxygen saturation spontaneously and lastly, the dose of cardiac support in the form of dopamine infusion. Mean, ranges and percentages of the different parameters were calculated. A list of underlying diseases was also tabulated with percentages.

A comparative analysis of various parameters at start of ambu bagging and at the time of extubation was done. During intubation the ambu bagging was done by doctor on duty and patient's attendants with an oxygen flow of 4-6 Lit/min. Regular assessment of vital signs and a regular arterial blood gas monitoring was being done. Fluid management was done as per standard protocols and all patients required a positive ionotropic support in the form of dopamine infusion throughout the bagging.

Weaning-off plan was undertaken on clinical judgment based on improvement of ABGs, conscious status, spontaneous breathing effort by the patient with minimum distress and improvement in the primary underlying disease. 3 doses of intravenous steroids in the form of dexamethasone were given 6 hours prior, at extubation and 6 hours later to avoid laryngeal edema. There was an extubation failure in 5 patients who were re-intubated

Results

A total 24 successively intubated patients including newborns were enrolled in the study as per inclusion criteria. Age group was from 0 to 36 months with mean of 6.5 months, 11(46%) male and 13(54%) female. The ambu bagging was done by doctor on duty and Patient's attendants with an oxygen flow of 4-6 Lit/min, and the minimum duration of bagging was >

Table-1: Underlying Diagnoses at the time of intubation with frequencies

S. No	Diagnosis	Frequency	Percentage
1	Pyomeningitis with aspiration pneumonia	03	12.5
2	Gastroenteritis with septicemia	03	12.5
3	Asphyxia Neonatorum Stage II	02	8.4
4	Asphyxia Neonatorum Stage II with Early onset of septicemia	02	8.4
5	Bronchopneumonia with morphine poisoning	02	8.4
6	Asphyxia Neonatorum Stage I	01	4.2
7	Post Asphyxial damage with sepsis	01	4.2
8	Bronchopneumonia with sepsis	01	4.2
9	Late onset neonatal sepsis	01	4.2
10	Status Asthmaticus	01	4.2
11	Infantile spasm with sepsis	01	4.2
12	Post Local Anesthesia with Lignocaine for circumcision	01	4.2

Table-2: Clinical and lab parameters at the time of Intubation & extubation.

Parameter		Intubation	Extubation
PH	Range	6.9-7.4	7.28-7.41
	Mean	7.13	7-36
CO 2	Range	22-86	16-42
	Mean	43	29
HCO3	Range	8-32	12-26
	Mean	17	18
O2 SAT	Range	50-86	90-99
	Mean	64	94
Rate of Oxygen	Range	2-5	2-5
	Mean	3.5	3.5
GCS	Range	3-13	13-15
Pupil		Constricted 6	Constricted 1
		Dilated 18	Dilated and reactive 23
Spont resp effort		Absent 1	Present 24
		Gasping 2	
		Poor 14	
		Present 7	
Resp Distress		Present 10	Present 6
		Nil 14	Nil 18
CXR1		Normal 12	Improved 8
		Pathology 12	Normal 14
			Same 2

Table-3: Clinical and lab parameters of patient who recovered after extubation and those who were re-intubated.

Parameter	Recovered	Re-intubated
Total	19	5
Hours of intubation	25	49
TLC	22300	23800
CRP	16	21
Heart rate at intubation	120	123
Heart rate at extubation	124	127
RR at intubation	27	36
RR at extubation	46	52
Oxygen Saturation	63	62
	94	93
Rate of Oxygen	3.5	3.5
	3.3	3.5
GCS	6	4
	14	13
Dopamine Dose	7.6	7.0
	12.6	12
PH	7.1	7.1
	7.5	7.39
Co2	43	26
	30	28
HCO3	16	21
	18.5	18.5

24 hours. Main underlying diagnoses at time of intubation, in order of frequency were, Asphyxia neonatorum Stage II with or without sepsis & meconium aspiration(21%), Prematurity with Respiratory distress syndrome (16.7%), Bronchopneumonia with Sepsis and/or morphine poisoning (12.5%), Pyogenic meningitis (12.5%), gastroenteritis with sepsis (12.5%) and status asthmaticus (4.2%) **Table 1**. All these 24 were patients were weaned-off from manual ambo bagging, on clinical judgment and available lab parameters **Table 2.** Among these 24 extuabted patients, 19 remained normal and 5 were re-intubated. 2 were intubated within <24 hours and 3 after first 24 hours. Probable causes of reintubation were, DIC in 2 cases, Laryngeal edema in 1 case and in the remaining 2 cases, cause of reintubation was unknown. Outcome: 19 patients who were successfully extubated were cured and discharged. Among 5 re-intuabted patients 2 were discharged after extubation later, 2 expired and one patient got LAMA. The clinical parameters of successfully weaned-off (19) cases and those re-intubated were also compared **Table 3.**

Discussion

Availability of mechanical ventilators in adequate numbers fulfilling the need of sick patients has always been an issue in our country. According to a report published in there were only 150 ventilators in the city of Karachi for 18 million people.[8] In another report published in 2013 it was mentioned that teaching hospitals have multidisciplinary ICUs while there are a total of 480 ICU beds in Karachi in different types of Intensive Care Units which include medical, pediatric and neonatal ICUs. Only 15-20% of these ICUs have purpose built facilities, teaching facilities for staff and residents are available in 1-2%, 20-25% had proper ICU beds, 40-50% of these ICUs have working ventilators with new latest equipment, 30% have supporting equipment but just 5-10% have arrangements for In-house drugs delivery, otherwise most of these ICUs ask the patient attendants to arrange for drugs.[9] Similarly a fresh report published in Jan 2016 mentioned a total of 62 ventilators in public sector hospitals in Rawalpindi for a population of 5 million people, out of which 10 ventilators were out of order.[10] We also face a lack of adequate numbers of mechanical ventilators for sick children in our set up. Most of the time the available ventilators are occupied and due to a heavy input of sick children many of them need to be manually ventilated by Ambo bagging with endotracheal tube and an oxygen source. Although it is a crude method of ventilation, as inspiratory pressure, tidal volume, positive end expiratory pressure, I:E ratio and FiO2 cannot be measured, but still a good number of patients are weaned-off successfully by monitoring other available parameters. The mainstay of monitoring these manually ventilated children is a regular arterial blood gas analysis which can at least guide about the pH, HCO3, PaCO2 & PaO2. Other clinical parameters that can be monitored include conscious status, pupillary reaction, spontaneous breathing effort, improvement of primary disease and lowering requirement of oxygen. Another interesting observation in our study was that there was not a single case of pneumothorax despite the fact that pressures couldn't be measured or controlled during manual bagging.

Regarding various clinical parameters of weaning, the IARS (International Anesthesia Research Society) published a report regarding predictors of weaning and a Glasgow coma scale of more than 12 was considered a good predictor.[11] Same was true in our study where children had a mean GCS of 5 at intubation and 13 at extubation. In the same report a PaCO2 at baseline and a PaO2 more than 60 were also considered to be a good predictor of weaning from ventilation in association with other factors.[11] Similar was the observation in our study where a mean PaCO2 of 54 at intubation was followed by a mean PaCO2 of 29 at extubation.

Similarly a mean oxygen saturation of 64 at intubation and 94 at extubation reflected the importance of O2 sat during monitoring of ventilation in our study. A study conducted in Spain regarding the predictors of weaning from ventilation also mentioned the importance of easy wakefulness and an oxygen saturation of more than 90% as good predictors of weaning.[12] We also noted the reaction of pupils at the time of intubation and later at extubation. It was a significant finding as the pupillary reaction was constriction in 25% and mid dilatation with sluggish response in remaining 75% at the start of ventilation. It improved to normally reacting pupils in 96% of the children at extubation. A similar observation was mentioned in a review article published in 2007, where reactive pupils were considered as an important predictor of weaning from ventilation.[13] another study published in Egypt statistically proved the fact that a lower PaCO2 and a lower HCO3 were present in patient who could be weaned, as compared

Find a significant difference in arterial HCO3 at the time of intubation and extubation, but the children who were re-intubated within 48 hours had a higher HCO3 than those who were successfully extubated.

Conclusions

Ambo bagging with endotracheal tube and oxygen flow can survive patients. Monitoring of such patients can be done by vitals, serial arterial blood gases, oxygen saturation and the flow of oxygen required to maintain saturation. Treatment of primary disease leading to improvement of symptoms and clinical parameters can give a judgment regarding extubation. Arterial blood gas remained the main tool for following such patients.

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